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A review of: "Strategy for the detection and study of other planetary systems and extrasolar planetary materials"

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BOOK REVIEW

STRATEGY FOR THE DETECTION AND STUDY OF OTHER PLANETARY SYSTEMS AND EXTRASOLAR PLANETARY MATERIALS. Report of the Committee on planetary and Lunar exploration Space Studies Board. National Academy Press: Washington D.C., 1990.

The Committee on Planetary Exploration of the Space Science Board (COMPLEX) has a long history. Its first 5 Reports concerned the studies of the Solar system and were used to set the guidelines of ground-based and space research in this field. It is now clear that further advances in the solution of the fundamental problem of the origin of the Solar system can only be made through the study of other planetary systems (PS). Recent advances of the observational techniques make the discovery of PS a feasible task. The attention of the COMPLEX was thus turned to this intriguing problem.

This book is a summary of the COMPLEX Report prepared by 29 of its present and former members. After a short Introduction it starts with the definition of relevant nomenclature. In particular, a clear distinction is made between planets and more massive "substellar objects" that are believed to be quite different in their nature and formation mechanisms. Then the basic scientific goals of the PS investigation are formulated. The major one is the discovery of PS and the statistical study of their frequency, planetary masses and dynamic properties. In parallel the studies of the protoplanetary systems and circumstellar dust are to be pursued as well as the theoretical and laboratory studies of planetary formation, binary stars and other related subjects.

The review of the present understanding of the origins of stars and planets is given. It is supplemented with the review of observational and theoretical data on circumstellar material that seems to be related to early stages of planetary formation. With this substantial introduction the report comes to the main question: what is to be done to discover and study other planetary systems?

The direct detection of planets is reviewed and found to be very problematic both in the optical and in the infrared regions of the spectrum. Some attempts are however planned with the existing or future space telescopes. The indirect detection of PS is based on the measurement of the reflex motion of the central star caused by the gravitational influence of the planets. This motion in the plane of sky can be detected by the astrometric techniques while the motion in the line-of-sight is evidenced by the changes of radial velocity measured from doppler shifts of spectral lines. Both of these basic techniques, astrometry and doppler spectroscopy, are potentially able to detect Jupiter-sized planets around hundreds of nearby stars. They are also complementary as can be seen from the diagram "separation-mass" given on Figure 5.2. There is yet another method of PS detection based on the observation of changes of stellar brightness caused by the projection of a planet on the stellar disk. However this technique is recognized to be unsuitable for the statistical studies due to exceedingly low detection rate.

To achieve a useful detection rate of PS with the astrometric technique an increase of the accuracy of 2 orders of magnitude (to 10^{-5} seconds of arc) over current ground-based instruments is required. To this end it is highly recommended to study the specialized space mission. The Astrometric Telescope Facility on the Space Station is one of the possibilities while the astrometric interferometers such as POINTS can provide still better sensitivity but are less well studied. In the meanwhile the ground-based efforts should be continued. The doppler measurements are carried out from the ground and the techniques to achieve the velocity precision of 10 m/s are presently at hand. Both astrometric and doppler programs require at least 10 years of observations. The development of the long-term space mission and the support of ground-based doppler programs are the major practical recommendations of this Report.

The studies of circumstellar planetary materials are well under way with the detection of the infrared emission of dust disks around several stars. These studies will greatly benefit from the future infrared space telescopes and ground-based interferometers.

The subjects related to the problem of planetary formation were not overlooked by COMPLEX as well. Among them are the early stages of stellar formation, the statistics of binary stars, the theory of stellar evolution, etc. Finally, the connection with the problem of the search of extraterrestrial intelligence was also mentioned.

The overall impression from the Report is that the fascinating problem of the studies of other planetary systems has now entered into the "technological" phase. It means that given the sufficient funding and several years of observations we are sure to be able to discover other planetary systems or otherwise prove that they are a very rare phenomenon.

A. Tokovinin